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METHODOLOGY FOR IDENTIFYING ABILITIES FOR JOB SPECIALTIES (MIDAS)

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A methodology for assessing ability requirements for Air Force occupational specialties is demonstrated. Ratings of the importance of 28 abilities were obtained from subject-matter experts in four enlisted and four officer specialties. The ratings showed high interrater reliability. The ratings were consistent with conventional expectations about pilot and nonpilot officers and about the enlisted specialties. Further, factor analysis demonstrated factors of verbal, quantitative, and psychomotor domains as have often been found from factoring test batteries, providing further evidence of the logic validity of the methodology.

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PREFACE

The USAF Armstrong Laboratory Human Resources Directorate has joint-service responsibility for development of measures for selection and classification. This effort contributes a methodology for deciding what measures should be developed. This was accomplished under contract F41689-88-D-0251, Task 53 to Metrica, Inc. with principal investigator, Dr. W.E. Driskill and monitored by James A. Earles, AL/HRMIM.

METHODOLOGY FOR IDENTIFYING ABILITIES FOR JOB SPECIALTIES (MIDAS)

I. INTRODUCTION

Background

This report describes a methodology for assessing ability requirements for Air Force occupational specialties. Initial research was conducted by Driskill, Weissmuller, Hageman, and Barrett (1989). This research reviewed existing methodologies for determining ability requirements from occupational analysis data reported by the U.S. Air Force Occupational Measurement Squadron (USAFOMS). Specifically, 36 general and special purpose taxonomies previously used to describe job or worker characteristics were identified and reviewed. The Ability Requirements Scale (ARS) method developed by Fleishman and Mumford (1988) was recommended as being the most appropriate for identifying ability requirements of Air Force occupational groups. This ARS approach, with modification[1], was the most compatible with existing Air Force occupational task analysis data, provided the most extensive coverage of abilities, and gave the most direct link with tests of specific abilities.

Driskill et al. (1989) described an Occupational Survey Methodology (OSM) Abilities Requirements Scale (ARS) approach for linking the verb (the action) level of a task to abilities across jobs. Job analyses have been completed on most Air Force jobs using an Air Force-developed methodology connected to a set of program subroutines (Comprehensive Occupational Data Analysis Programs, CODAP). It was suggested that where USAFOMS occupational analysis data did not exist (some Air Force officer specialties), the General Work Inventory (Ballentine & Cunningham, 1981) could be used as an alternative to the action-verb approach for describing work performed. Recommendations for follow-on research included a pilot test study of this verb-ability taxonomy involving a small number of enlisted and officer specialties. Specific issues to be addressed as part of this pilot test included: a) the reliability of subject-matter-expert judgement about ability requirements relative to action verbs and General Work Inventory (GWI) element information, b) the qualitative similarity of judgements from the two sources of descriptive information (verb versus GWI element), and c) the degree to which specialties are differentiated by ability ratings.

In addition, the study suggested that use of a mail survey approach be assessed. Typically, the ARS is group-administered and frequently considerable training of raters' on meaning of abilities and rating requirements is provided. Group administration has resulted in useful ability ratings. Such administration, given the number of Air Force specialties, would be resource-intensive and expensive. Mail survey collection of ability ratings (if found to provide useful ratings) could be far less resource-intensive.

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[1] The authors pointed out that ARS taxonomy utility could be improved for Air Force use by adding selected interpersonal abilities and additional psychomotor abilities.

Dittmar and Ringenbach (1991), in follow-on research, prepared the necessary ground work for a pilot test study of the verb-ability taxonomy. Their work focussed on four major objectives. The first involved the identification of a comprehensive taxonomy of abilities applicable to successful performance of work within Air Force specialties. The second concerned the selection of the eight specialties (four enlisted and four officer) to be surveyed. The third identified verbs and GWI elements to be used to describe the work performed within the eight specialties. The last objective involved the development of the prototype survey instruments to be used to elicit ability ratings from subject-matter experts. Following is a summary of the work performed with respect to each of these four objectives.

A literature review was conducted to determine the cognitive, perceptual, psychomotor, and interpersonal ability factors that could be used in the Air Force setting. The primary source of reference for the cognitive and psychomotor domains was Theologus, Romashko, and Fleishman (1970). A set of 37 abilities, including the definition of the ability and task examples, was taken from this work to be included in the Air Force abilities taxonomy. Other sources of reference for the cognitive and psychomotor domains were Siegel, Federman, and Welsand (1980) and Carretta (1990). The main source used in identifying interpersonal abilities was a factor analytic study of the General Work Inventory (Cunningham, Wimpee, & Ballentine, 1990). The complete abilities taxonomy consisted of 53 cognitive, psychomotor, and interpersonal abilities.

Although this set of 53 abilities formed a very comprehensive taxonomy, it was too large for mailout survey application. Additionally, most ability definitions were thought to be too complex and academically oriented for practical use with Air Force enlisted and officer populations. As a result, a reduced set of 28 abilities was identified for "mailout" purposes. This set consisted of 15 cognitive, 6 psychomotor, and 7 interpersonal abilities. The primary rationale used to select these abilities was the identification of a set of abilities that were as distinct as possible (i.e., minimum overlap among abilities), and a set of abilities that appeared to have some potential for identifying differences among the Air Force specialties. Specifically, this reduced set included those that could be related to the verbal, speed, and quantitative factors thought to be measured by the Armed Services Vocational Aptitude Battery (ASVAB), and to spatial, perceptual, and psychomotor abilities thought to be important for pilots. Ability definitions for this reduced set were also simplified, to the extent possible, to improve respondent understanding. Appendix A is this reduced set of abilities and their modified definitions.

Selection of the eight Air Force specialties (AFSs) to be surveyed was accomplished sequentially. A set of 67 enlisted and 19 officer AFSs surveyed by the USAF Occupational Measurement Squadron between January 1986 and February 1990 was reviewed to eliminate those AFSs jointly surveyed and those with less than 400 members. Second, AFSs with less than 10 task statement verbs accounting for 80 percent or more of their inventory tasks, and AFSs with more than 25 verbs required to account for 80 percent of their inventory tasks were also eliminated from further consideration. The final set of eight specialties was selected to minimize the number of task statement verbs common across specialties, and to allow MAGE

aptitude group representation among the four enlisted areas (mechanical - M, administrative - A, general - G, and electronics - E). Table 1 is a list of the eight specialties selected.

Table 1. AFSs Selected

AFSC (Aptitude)	AFS Title
	Enlisted AFS
271X2 (A45)	Operations Resources Management
411X2A (E33)	Missile Facilities
464X0 (M61/E46)	Explosive Ordnance Disposal
924X0 (G43)	Medical Laboratory
	Officer AFS
49XX	Communications-Computer Systems Staff Officer
70XX	Information Management
X-Prefix	Flight Safety Officer
1045/1055/1065/ 1115/1235/1355	Pilot

Following the recommendations of Driskill et al., two parallel methods of describing the work performed within occupational groups (Air Force specialties) were used. The first of these two methodologies involved the use of task-statement verbs to describe work performed (CODAP-based method). The second methodology was based on the General Work Inventory (GWI) and involved the use of "work elements" to describe work performed (GWI-based method).

The CODAP-based method focussed on the identification of those verbs appearing most frequently in the task inventories of the AFSs to be surveyed. Verbs were first ordered on frequency of appearance (most frequently appearing verb first), then selected until the set of verbs selected was contained in at least 80 percent of the task statements[2]. Table 2 specifies the number of verbs selected within each AFS. In order to make these sets of verbs more

[2] Prior to verb selection, survey data were processed to eliminate all tasks within Duties A, B, C, and D to restrict verb selection to "technical" tasks.

meaningful to survey respondents, verb definitions and example task statements were also developed for each verb[3].

Table 2. Number of Verbs Selected		
AFS	**Number of Verbs Selected**	**Percent of Task Covered**
271X2	18	81%
411X2A	10	93%
464XO	21	80%
924XO	12	86%
49XX	24	80%
70XX	22	84%
X-Prefix	17	80%
Pilot	19	80%

The GWI-based method involved the identification of "work elements" to describe the work performed. In order to assess the relevance of the 268 work elements comprising the GWI with respect to each of the eight AFSs, the GWI was first administered to an incumbent sample within each specialty. Table 3 shows sample sizes, resulting return rates and interrater reliabilities for a single rater. Survey results were analyzed to select those "work elements" considered descriptive[4] of the work performed within each AFS. Each selected work element

[3] A maximum of 15 example task statements were selected for each verb. When more than 15 task statements containing the verb of interest existed in the task inventory, stratified random sampling (percent member performing for officer AFSs and Task Learning Difficulty for enlisted AFSs) was used to select the 15 tasks.

[4] Work elements rated by at least one-half of the raters within a specialty, and with mean values of 5 or greater (GWI used a 9-point part-of-job scale), were considered descriptive of the work performed.

was then converted to task statement form for clarity[5]. Table 4 specifies the number of "work elements" identified for each of the eight AFSs.

Table 3. GWI Sample Sizes, Return Rates, and Reliabilities

AFS	Sample Size	Surveys Returned (Rate)	R_{11}
271X2	70	26 (37%)	.39
411X2A	70	34 (49%)	.31
464XO	66	32 (48%)	.41
924XO	70	33 (47%)	.35
49XX	70	39 (56%)	.39
70XX	70	25 (36%)	.49
X-Prefix	74	18 (24%)	.40
Pilot	105	25 (24%)	.42

Table 4. Number of Work Elements

AFS	Number of Work Elements Identified
271X2	20
411X2A	26
464XO	35
924XO	39
49XX	21
70XX	24
X-Prefix	28
Pilot	24

[5] After reviewing the 8 sets of GWI elements selected, it appeared that the use of verbatim element descriptions would result in some loss of meaning. For example, element E130, "FLYING VEHICLES -- (Examples: airplanes, helicopters, etc.)," did not appear to completely describe the work activity of interest. It seemed that the element would be better stated by combining both the element subsection description "E-1. Tools/Equipment/Machines Used or Operated" and the key words of the element to form a task statement such as "Use or operate flying vehicles." Therefore, the selected GWI work elements descriptions were combined with element subsection descriptions to form task statements.

Separate prototype survey booklet versions were developed for each of the two methods -- CODAP-based and GWI-based. The initial prototype versions contained a single section (Section I) designed to yield "importance-of-ability" ratings for given verbs (CODAP-based) or given task statements (GWI-based). In this section, incumbents were asked to assign ability importance ratings to each verb or statement using an absolute 11-point scale (Highest Importance = 0, Lowest Importance = 10). This section addressed the major thrust of the research -- assessing ability importance across occupational groups. Two additional sections were eventually added to these prototype survey booklet versions. A Section II was added to establish baseline ratings with respect to ability level. In this Section, incumbents were asked to use a 7-point scale (7 = Very High Ability Level, 1 = Very Low Ability Level) to rate the degree to which each of the 28 abilities included in the taxonomy was possessed by the average college graduate and then by a fully qualified officer assigned to the AFS of interest. For the enlisted specialties, incumbents assigned ratings with respect to the average high school graduate and then journeyman (5-skill level) within the AFS. It was hoped that the resulting data would provide additional insight not only into selection issues, but also training issues; i.e., large differences in ability level between the average high school graduate and the journeyman could imply a high level of training importance for the ability. A Section III was also added as a potential measure of verb and task statement relative importance in terms of consequences of inadequate performance. In this last section, incumbents were asked to assign percentage ratings to each verb or task statement reflecting the percentage of work in their career field that, if performed incorrectly, could result in severe injury or death. It was anticipated that the resulting data could be used to enhance the assessment of ability importance levels across the Air Force specialties sampled. Appendix B provides an example of a CODAP action verb task, a GWI element, the abilities rating response collection page, and the 11-point rating scales.

Scope

This current research effort was designed to meet two broad objectives. The first was refinement of the previously developed prototype survey booklets. The second was the analysis of survey results from a tryout of survey collections in the eight jobs.

Prototype survey booklets were evaluated during a series of small-group administrations within a number of Air Force specialties (AFSs). Of primary concern was the assessment of the clarity of survey instructions, survey administration time, and overall suitability of survey formats for mailout application. Survey booklet refinements were made on the basis of small-group administration results.

Analysis of survey results was designed to address a number of important questions. The first dealt with the degree to which raters agreed on ability requirements with respect to given verbs and GWI element task statements. The second area of investigation concerned the extent to which the AFS samples differed with regard to ability requirements and the validity of those reported requirements. The third involved the extent to which identical verbs and identical GWI elements tended to represent similar ability sets. The remaining area of concern

addressed the comparability of AFS ability requirements derived from the CODAP- and GWI-based approaches.

Report Organization

Section II of this report describes survey instrument refinement efforts (small-group administration and resulting instrument changes). Section III details mailout sample selection procedures and the survey mailout process. Section IV reports data analysis findings. Section V is a discussion of results, and Section VI contains recommendations for future research.

II. SURVEY INSTRUMENT REFINEMENT

A series of five pilot tests (small-group survey administration) was conducted to evaluate and refine the prototype survey instruments. Table 5 lists the Air Force specialties (AFSs) surveyed, number of personnel surveyed (N), and the location and dates of pilot tests.

Table 5. Pilot Tests

AFS	N	Location/Date
464X0	4	Lackland AFB/5 June 1991
70XX	2	Brooks AFB/11 July 1991
70XX	2	Randolph AFB/24 July 1991
49XX	2	Randolph AFB/5 August 1991
Pilot	4	Randolph AFB/25 October 1991

AFS 464X0 Administration

This initial pilot test was conducted in a highly interactive manner; incumbents' perceptions were actively solicited throughout the survey administration process. Two of the incumbents completed the General Work Inventory (GWI) version of the survey and two incumbents completed the task-statement verb (CODAP) version. Administration times for both versions exceeded 2 hours. Incumbents appeared to have little trouble understanding and

using the abilities taxonomy[6]. However, all incumbents reported difficulty in using the 11-point, importance-of-ability scale[7] associated with the prototype survey instruments.

AFS 70XX Administration (1)

Administration time for both survey versions again exceeded 2 hours. Both incumbents found the 11-point scale usable but initially confusing. Both felt that the survey instrument in its present form would be quite time-consuming to complete. Incumbents were especially concerned that Section III of the survey instrument[8] appeared very difficult to understand and complete.

AFS 70XX Administration (2)

With Section III removed, survey administration time for both versions still exceeded 1 hour. One of the incumbents again expressed concerns with respect to the complexity of the 11-point scale.

AFS 49XX Administration

Administration time for both versions was approximately 2 hours. The incumbents found the 11-point scale difficult to understand and use. More importantly, they felt that these surveys would be very difficult to complete if received by mail.

Survey Instrument Revision

Given the results of these four pilot tests, two major problems were obvious. The first concerned the utility of the 11-point importance-of-ability scale. The second problem was excessive survey administration times. Almost all incumbents found the importance-of-ability scale difficult to understand and use. After evaluating a number of scale alternatives, a simplified, 9-point scale (9 = extremely high importance, 1 = extremely low importance) was adopted. This scale was simplified to remove anchors to a given percentage of tasks or actions

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[6] The abilities taxonomy (Abilities List) associated with the prototype surveys consisted of a set of 28 defined abilities with behavioral examples describing high, moderate, and low levels of each ability.

[7] The 11-point, importance-of-ability scale (0 = the highest importance, 10 = the lowest importance) used with the prototype survey instruments was designed to be an absolute scale. Each scale point was anchored to a given percentage of tasks or actions that could be successfully performed by individuals with average levels of the ability of interest.

[8] Section III of the prototype survey booklet was designed to elicit ratings regarding the impact of incorrect performance of verbs or actions.

that could be successfully performed by individuals with average ability levels. Additionally, scale numbering was reversed to equate high importance with high scale numbers and low importance with low scale numbers. Appendix C shows the 9-point rating scale.

In order to reduce survey administration time, the following instrument revisions were made. First, Section III of both the task-statement verb (CODAP) and GWI survey versions was eliminated. It was felt that the value of the ratings (assessment of the impact of incorrect task performance) elicited by this section did not justify the difficulty and time associated with its completion. Second, task-statement verb (CODAP) versions were modified to limit the number of verbs to be rated to 10 and to limit the number of associated example task statements to a maximum of 5[9]. Finally, GWI versions were modified to limit the number of GWI task statements to be rated to a maximum of 25[10].

Pilot Administration

Revised survey instruments for both versions were administered to four incumbents. Average administration time for each version was approximately 1 hour. All incumbents found the revised 9-point scale easy to use. Additionally, all thought that the revised surveys could be successfully administered by mail.

III. SAMPLE SELECTION

Two samples of N = 100 were drawn where possible. Sample selection for the enlisted Air Force Specialties (AFSs) was restricted to 7-skill levels[11] assigned to the CONUS, with dates of separation later than 9203 and no pending personnel actions (i.e., PCS, school assignments, etc.). Sample selection for the officer specialties was restricted to O-3s[12] assigned to the CONUS with no pending personnel actions.

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[9] The 10-verb sets were selected on descending cumulative percent time spent on tasks using the verb. Example tasks were selected on descending percent members performing (PMP).

[10] Where GWI task-statement sets associated with prototype versions exceeded 25, task statements with the lowest part-of-job values were eliminated.

[11] Where sufficient numbers of 7-skill levels did not exist, samples were supplemented with 5-skill levels.

[12] Where sufficient numbers of O-3s did not exist, samples were supplemented with O-2s and then O-4s.

IV. ANALYSIS OF RESULTS

Survey Return Rates

The average survey return rate across occupational groups and survey version was 32 percent. Table 6 lists return rates by occupational group and survey version.

Table 6. Survey Return Rates

AFS	Survey Version	Sample N	Return Rates
271X2	CODAP	100	31%
	GWI	100	27%
411X2A	CODAP	100	33%
	GWI	100	36%
464XO	CODAP	100	39%
	GWI	100	23%
924XO	CODAP	100	34%
	GWI	100	28%
49XX	CODAP	100	44%
	GWI	100	33%
70XX	CODAP	100	34%
	GWI	100	33%
X-Prefix[a]	CODAP	82	36%
	GWI	83	36%
Pilot	CODAP	100	21%
	GWI	100	23%

[a] Population size was not sufficient to allow samples of 100.

Reliabilities

Rater reliabilities were calculated using GRPREL, a subroutine of CODAP. Interrater reliabilities for a single rater (R_{11}) and for each composite of N raters (R_{KK}) were calculated for each verb and GWI statement within each Air Force specialty (AFS). Table 7 contains a

summary of these reliabilities for each AFS. Overall, reliabilities appeared to be satisfactory for both methods, with no clear superiority with respect to either method.

Table 7. Reliability Estimates

AFS (Method)	R_{11}		R_{KK}	
	Range	Median	Range	Median
271X2 (verb)	.16 - .43	.23	.86 - .95	.90
271X2 (GWI)	.08 - .44	.385	.71 - .95	.94
411X2A (verb)	.15 - .34	.21	.85 - .93	.90
411X2A (GWI)	.06 - .41	.17	.69 - .95	.88
464X0 (verb)	.12 - .38	.15	.82 - .95	.88
464X0 (GWI)	.10 - .59	.41	.74 - .97	.94
924X0 (verb)	.13 - .59	.28	.83 - .98	.93
924X0 (GWI)	.10 - .56	.34	.82 - .97	.92
49XX (verb)	.29 - .50	.435	.94 - .98	.97
49XX (GWI)	.14 - .53	.42	.84 - .97	.95
70XX (verb)	.16 - .49	.45	.86 - .97	.96
70XX (GWI)	.12 - .49	.38	.82 - .96	.95
X-Prefix[a] (verb)	.37 - .50	.44	.95 - .97	.96
X-Prefix[a] (GWI)	.13 - .50	.27	.81 - .96	.92
Pilot (verb)	.18 - .38	.28	.83 - .93	.885
Pilot (GWI)	.12 - .50	.345	.80 - .96	.925

Factor Structures

As an initial step, an in-house factor analysis program, MAX-FACTOR, was used to reduce both the CODAP-based (verbs) and the GWI-based (elements) data sets in order to compare their respective factor structures. This was done to determine whether similar factors emerged from the two data sets, and the extent to which they discriminated among the eight occupational groups (AFSs).

Mean ability ratings were computed for each of the 81 verb/rater sets. This process yielded a vector of 28 means (one for each ability contained in the taxonomy) for each of the 81 verb/rater sets. Pearson correlations were then calculated between each pair of vectors to form an 81 X 81 matrix of intercorrelations. Similarly, a vector of mean ability ratings was computed for each of the 189 GWI element/rater sets. The correlation between each pair of these vectors was also calculated to form a 189 X 189 matrix of intercorrelations. Both

matrices were then subjected to principal factors factor analysis and VARIMAX rotation. Table 8 contains the resulting eigenvalues and the associated percent of variance for which they accounted. Tables 9 and 10 list factors with loadings of at least .50, along with predominant abilities for verbs and elements, respectively.

Table 8. Eigenvalues

CODAP-Based		GWI-Based	
Eigenvalue	**Percent Variance**	**Eigenvalue**	**Percent Variance**
40.5	50.1	104.4	55.2
12.9	16.0	27.8	14.7
8.9	11.0	22.7	11.9
4.3	5.3	6.7	3.5
2.5	3.1	5.0	2.7
1.7	2.1	3.4	1.8
1.4	1.8	2.9	1.7
1.1	1.4	2.4	1.3
		1.8	.9
		1.6	.8
		1.5	.8
		1.3	.7
Total Variance	90.8		96.0

TABLE 9. FACTOR STRUCTURE (VERBS)								
Verb (AFS)	Factor 1 Loadings	Predominant Abilities	Verb (AFS)	Factor 2 Loadings	Predominant Abilities	Verb (AFS)	Factor 3 Loadings	Predominant Abilities
Advise (70XX)	.96	VE/VC	Input (271X2)	.88	NF/MR	Install (4112A)	.93	FD/AH
Coordinate (X-Prefix)	.96	VE/C	Perform (271X2)	.88	MR/NF	Remove (411X2A)	.92	VC/SS
Establish (49XX)	.96	A/VE	Audit (271X2)	.86	NF/VC	Service (411X2A)	.91	VC/AH
Conduct (X-Prefix)	.95	PI/VE	Calculate (924X0)	.83	MR/NF	Dispose (411X2A)	.82	SS/VC
Conduct (70XX)	.95	VE/VC	Maintain (271X2)	.81	IO/VC	Op Check (411X2A)	.82	VC/VE
Develop (70XX)	.95	VE/VC	Maintain (464X0)	.74	IO/VC	Adjust (411X2A)	.81	AH/VC
Write (X-Prefix)	.95	VE/PI	Record (924X0)	.71	VC/IO	Operate (464X0)	.80	VC/MC
Coordinate (70XX)	.93	VE/VC	Run (924X0)	.70	DR/VC	Prepare (924X0)	.79	VC/IO
Plan (70XX)	.93	VE/VC	Review (49XX)	.69	VC/DR	Clean (924X0)	.76	FD/AH
Write (49XX)	.93	VE/VC	Research (464X0)	.67	VC/DR	Stain (924X0)	.74	FD/AH
Conduct (49XX)	.93	A/VC	Interpret (Pilot)	.67	VC/DR	Initiate (464X0)	.73	FD/VC
Participate (49XX)	.92	VE/VC	Perform (924X0)	.65	VC/FD	Inspect (411X2A)	.73	VC/DR
Prepare (X-Prefix)	.90	VE/PI	Maintain (924X0)	.64	IO/VC	Troubleshoot (411X2A)	.70	DR/VC
Prepare (70XX)	.90	VE/VC	Request (271X2)	.64	IO/VC	Render Safe (464X20)	.59	WE/VC
Provide (49XX)	.90	VE/A	Monitor (271X2)	.64	DR/VC	Perform (924X0)	.57	VC/FD
Draft (70XX)	.90	VE/VC	Maintain (411X2A)	.61	VC/IO	Draw (924X0)	.56	AH/FD

TABLE 9. FACTOR STRUCTURE (VERBS) (Continued)

Verb (AFS)	Factor 4 Loadings	Predominant Abilities	Verb (AFS)	Factor 5 Loadings	Predominant Abilities
Fly (Pilot)	.91	SO/TS	Perform (464X0)	.79	O/DR
Accomplish (Pilot)	.91	SO/CRT	Prepare (464X0)	.77	DR/O
Perform (Pilot)	.88	SO/CRT	Dispose (464X0)	.64	VC/WE
Make (Pilot)	.86	CRT/IO	Render Safe (464X0)	.61	WE/VC
Maintain (Pilot)	.83	SO/V	Determine (464X0)	.52	DR/VC
Apply (Pilot)	.62	V/SO			
Estimate (Pilot)	.62	PS/SOC			
Interpret (Pilot)	.59	VC/DR			
Analyze (Pilot)	.55	IR/DR			

A = Assuming Responsibility
AH = Arm - Hand Steadiness
CRT = Choice Reaction Time
C = Cooperating
DR = Deductive Reasoning
FD = Finger Dexterity
IR = Inductive Reasoning
IO = Information Ordering
MR = Mathematical Reasoning
MC = Multilimb Coordination
NF = Number Facility
O = Originality
PI = Persuading/Influencing
PS = Perceptual Speed
SO = Spatial Orientation
SS = Static Strength
SOC = Speed of Closure
TS = Time-Sharing
V = Visualization
VC = Verbal Comprehension
VE = Verbal Expression
WE = Working Effectively in Uncomfortable Human Situations

TABLE 10. FACTOR STRUCTURE (ELEMENTS)

Elements (AFS)	Factor 1 Loadings	Predominant Abilities	Elements (AFS)	Factor 1 Loadings	Predominant Abilities	Elements (AFS)	Factor 1 Loadings	Predominant Abilities
B12 (Pilot)	.96	MR/IO	B26 (Pilot)	.89	DR/IR	B26 (924XO)	.81	IR/DR
B12 (X-Prefix)	.95	MR/IO	B71 (924X0)	.88	IR/VC	B73 (464XO)	.80	DR/IR
B12 (49XX)	.95	MR/DR	B39 (411X2A)	.88	VC/MR	B25 (49XX)	.78	IO/VC
B14 (70XX)	.94	DR/MR	B26 (X-Prefix)	.87	IR/DR			
B14 (Pilot)	.93	MR/IO	B29 (271X2)	.86	MR/NF			
B14 (X-Prefix)	.93	IO/MR	B13 (924X0)	.86	MR/VC			
B37 (Pilot)	.93	DR/IR	E115 (Pilot)	.86	M/MR			
B12 (271X2)	.92	MR/NF	B15 (464X0)	.85	DR/MR			
B12 (924X0)	.92	MR/NF	B13 (Pilot)	.84	M/NF			
B37 (X-Prefix)	.92	DR/V	B69 (Pilot)	.84	IR/V			
B12 (49XX)	.92	MR/NF	B26 (464X0)	.84	DR/IR			
B14 (271X2)	.92	MR/DR	B15 (Pilot)	.83	MR/NF			
B173 (X-Prefix)	.91	DR/MR	B12 (464X0)	.83	MR/NF			
B15 (924X0)	.90	DR/IR	B17 (Pilot)	.82	VC/IO			
B15 (X-Prefix)	.90	NF/IR	B16 (X-Prefix)	.82	V/DR			
B29 (49XX)	.90	MR/NF	B26 (49XX)	.82	VC/IR			
B16 (Pilot)	.90	IO/DR	E115 (X-Prefix)	.82	DR/MR			

A = Assuming Responsibility
AH = Arm-Hand Steadiness
CRT = Choice Reaction Time
C = Cooperating
DR = Deductive Reasoning
FD = Finger Dexterity
IR = Inductive Reasoning
IO = Information Ordering
M = Memorization
MR = Mathematical Reasoning
MC = Multilimb Coordination
NF = Number Facility
O = Originality
PI = Persuading/Influencing
PS = Perceptual Speed
SO = Spatial Orientation
SS = Static Strength
SOC = Speed of Closure
TS = Time-Sharing
V = Visualization
VC = Verbal Comprehension
VE = Verbal Expression
WE = Working Effectively in Uncomfortable Human Situations

TABLE 10. FACTOR STRUCTURE (ELEMENTS) (Continued)

Elements (AFS)	Factor 2 Loadings	Predominant Abilities	Elements (AFS)	Factor 2 Loadings	Predominant Abilities	Elements (AFS)	Factor 2 Loadings	Predominant Abilities
B19 (271X2)	.98	VE/VC	B11 (271X2)	.91	VC/VE	B11 (411X2A)	.81	VC/VE
B20 (271X2)	.98	VE/VC	B21 (924X0)	.90	VE/VC	B63 (271X2)	.81	VC/VE
B20 (70XX)	.97	VE/VC	B21 (271X2)	.90	VE/VC	B11 (924X0)	.80	VE/IR
B20 (X-Prefix)	.96	VE/VC	B21 (411X2A)	.89	VE/VC			
B19 (411X2A)	.96	VE/VC	B11 (70XX)	.88	VC/VE			
B19 (924X0)	.95	VE/VC	B64 (70XX)	.87	VE/VC			
B20 (464X0)	.95	VE/VC	B11 (X-Prefix)	.87	VC/VE			
B20 (924X0)	.95	VE/VC	B22 (411X2A)	.86	VE/VC			
B19 (70XX)	.94	VE/VC	B21 (49XX)	.86	VE/VC			
B20 (49XX)	.94	VE/VC	B21 (X-Prefix)	.85	VE/IO			
B19 (464X0)	.94	VE/VC	B21 (464X0)	.85	VE/VC			
B54 (70XX)	.94	VE/VC	E113 (411X2A)	.84	VE/VC			
B19 (49XX)	.93	VE/PI	E113 (271X2)	.84	VE/VC			
B20 (Pilot)	.93	VE/VC	B53 (Pilot)	.83	VC/VE			
B19 (Pilot)	.92	VE/VC	B65 (70XX)	.82	VC/VE			
B64 (464XO)	.91	PI/VE	B63 (464X0)	.81	VC/VE			
B9 (X-Prefix)	.91	VE/VC	B21 (Pilot)	.81	VC/VE			

TABLE 10. FACTOR STRUCTURE (ELEMENTS) (Continued)

Elements (AFS)	Factor 3 Loadings	Predominant Abilities	Elements (AFS)	Factor 3 Loadings	Predominant Abilities	Elements (AFS)	Factor 3 Loadings	Predominant Abilities
E116 (70XX)	.96	FD/AH	E122 (49XX)	.83	FD/AH	E115 (271X2)	.51	FD/M
E117 (49XX)	.95	FD/AH	E133 (924X0)	.81	AH/FD	Elements (AFS)	Factor 4 Loadings	Predominant Abilities
E122 (411X2A)	.91	FD/AH	E108 (464X0)	.81	AH/FD	E176 (924X0)	.58	WE/A
E117 (70XX)	.91	FD/VC	E122 (70XX)	.81	FD/AH	E174 (924X0)	.53	DR/IR
E116 (924X0)	.90	FD/CRT	E156 (411X2A)	.81	FD/AH	B53 (X-Prefix)	.53	VC/DR
E116 (49XX)	.89	FD/AH	E114 (411X2A)	.80	FD/AH			
E122 (924X0)	.88	FD/AH	E160 (411X2A)	.78	AH/FD			
E119 (924X0)	.86	FD/AH	E113 (49XX)	.77	VC/FD			
E114 (924X0)	.86	FD/AH	E115 (924X0)	.75	FD/VC			
E122 (Pilot)	.86	FD/AH	E113 (70XX)	.75	FD/M			
E177 (271X2)	.85	FD/AH	B30 (70XX)	.64	VC/FD			
E169 (411X2A)	.85	FD/AH	E112 (Pilot)	.62	M/FD			
E165 (411X2A)	.84	AH/VC	B30 (924X0)	.62	VC/FD			
E122 (X-Prefix)	.84	FD/AH	B30 (464X0)	.57	VC/VE			
E161 (411X2A)	.84	FD/AH	E115 (49XX)	.57	VC/M			
E112 (X-Prefix)	.84	FD/VC	B30 (411X2A)	.56	VC/VE			
E108 (411X2A)	.83	FD/AH	B30 (271X2)	.51	FD/VC			

TABLE 10. FACTOR STRUCTURE (ELEMENTS) (Continued)								
Elements (AFS)	Factor 5 Loadings	Predominant Abilities	Elements (AFS)	Factor 6 Loadings	Predominant Abilities	Elements (AFS)	Factor 7 Loadings	Predominant Abilities
E130 (X-Prefix)	.91	SO/CRT	(No Loading ≥ .50)			E127 (464XO)	.67	CRT/MC
E130 (Pilot)	.85	SO/TS				E128 (464XO)	.58	MC/CRT
E173 (924XO)	.69	TS/PS				E127 (422X2A)	.53	MC/CRT
Elements (AFS)	Factor 8 Loadings	Predominant Abilities	Elements (AFS)	Factor 9 Loadings	Predominant Abilities	Elements (AFS)	Factor 10 Loadings	Predominant Abilities
B16 (49XX)	.59	V/DR	E173 (411X2A)	.52	A/WE	B35 (464XO)	.71	A/IO
B16 (464XO)	.51	V/DR				E159 (411X2A)	.52	A/SO

Of the eight factors extracted from the CODAP-based (verbs) data set, five had factor loadings of .50 or greater[13] (Table 9). Factor 1 appears to be a verbal factor characterized by VE (Verbal Expression). Officer AFSs (70XX, 49XX, and X-Prefix) seem to be differentiated by this factor to a greater extent than the enlisted specialties or Pilot. Verbs one would expect to have face validity with respect to a factor characterized by verbal expression (advise, write, draft) tend to have high factor loadings. Factor 2 appears to be somewhat more heterogeneous in that loadings are associated with number facility and reasoning abilities in addition to information ordering and verbal comprehension. Enlisted specialties (271X2, 924X0, 464X0, and 411X2A) seem to be differentiated by this factor. Relatively high loadings associated with the verbs "Input," "Audit," "Calculate," and "Record" give this factor a mathematical/information-ordering flavor. Factor 3 has a clear technical flavor, and is characterized by psychomotor abilities such as finger dexterity, static strength, and arm-hand steadiness. The three enlisted specialties differentiated (411X2A, 924X0, and 464X0) tend to be more "maintenance"-oriented than AFS 271X2 (Operations Resources Management) or the officer specialties. High loadings on the verbs "Install," "Remove," "Service," and "Adjust" support this contention. Factor 4 uniquely represents both the cognitive and the psychomotor abilities associated with the Pilot specialty. Factor 5 appears to be unique to AFS 464X0 (Explosive Ordnance Disposal) and seems to aptly describe this specialty in terms of the ability requirements of originality, reasoning, and working effectively in uncomfortable human situations. Factors 6, 7, and 8 were not interpreted, given the lack of factor loadings of .50 or greater.

Of the 12 factors extracted from the GWI-based (elements) data set, 9 had loadings of .50 or greater (Table 10). Factor 1 appears to be a quantitative/reasoning factor characterized by MR (Mathematical Reasoning), DR (Deductive Reasoning), IO (Information Ordering), and NF (Number Facility). Elements B12 (Receive or use information in the form of numbers or math symbols) and B14 (Receive or use information in the form of tables, graphs, or charts) have the highest factor loadings. There seems to be no apparent discrimination among the eight occupational groups. Factor 2 is clearly verbal in nature and is characterized by VE (Verbal Expression) and VC (Verbal Comprehension). Elements B19 (Speak using conversational English) and B20 (Speak using formal English) have the highest loadings on this factor. Again, there does not appear to be substantial discrimination among occupational groups with respect to this factor. Factor 3 is associated with psychomotor abilities -- primarily FD (Finger Dexterity) and AH (Arm-Hand Steadiness). Elements E116 (Use or operate keyboard equipment other than computing devices), E117 (Use or operate office machinery or equipment except keyboard and computing devices), and E122 (Use hand-held writing, drawing, or marking devices) have high loadings. No obvious pattern of discrimination among occupational groups can be detected. Factor 4, with moderate loadings on E176 (Provide medical or health treatment or care), E174 (Inspect equipment, products, or facilities), and B53 (Use information about individuals such as resumes or job performance ratings), is

[13] Only factors with loadings equal to or greater than .50 were interpreted. Where more than 20 percent of loadings for any factor exceeded .50, only the highest 20 percent are displayed in Tables 9 and 10.

difficult to interpret. At best, this factor can be characterized as relating to interpersonal/reasoning abilities loosely related to AFSs 924X0 (Medical Laboratory) and X-Prefix (Safety Officer). Factor 5 is clearly cognitive/psychomotor in nature and is characterized by SO (Spatial Orientation), CRT (Choice Reaction Time), and TS (Time-Sharing). High loadings on element E130 (Use or operate flying vehicles) tend to support a "pilot" orientation. Factor 6 was not interpreted, given the lack of factor loadings of .50 or greater. Factor 7 is a psychomotor factor involving CRT (Choice Reaction Time) and MC (Multilimb Coordination) and appears related to E127 (Use or operate highway vehicles) and E128 (Use or operate off-road vehicles). Both AFS 464X0 (Explosive Ordnance Disposal) and AFS 411X2A (Missile Facilities) tend to be associated with this factor. Personnel within these AFSs use vehicles extensively in their work. Factor 8 appears to be related to V (Visualization) and DR (Deductive Reasoning), with a high loading on element B16 (Receive or use information in the form of drawings, pictures, and diagrams). This factor seems to be important for AFS 49XX (Communications-Computer Systems Officer) and AFS 464X0 personnel. Factor 9 seems to be interpersonal in nature and is characterized by A (Assuming Responsibility) and WE (Working Effectively in Uncomfortable Human Situations). This factor seems to be unique to AFS 411X2A personnel, with its highest loading on element E173 (Watch or monitor machines or equipment). Factor 10 also appears to be interpersonal in nature (Assuming Responsibility) and has its highest loadings on B35 (Stock or inventory materials, tools, or equipment) and E159 (Transport products, material, or people from one place to another). Factors 11 and 12 were not interpreted, given the lack of factor loadings of .50 or greater.

Comparisons of the CODAP-based (verbs) and GWI-based (elements) factor structures reveal both similarities and differences. Both structures contain a strong verbal factor (Factor 1 for verbs and Factor 2 for elements). Both structures also contain a quantitative/reasoning factor (Factor 2 for verbs and Factor 1 for elements). Factor 3 in both structures represents psychomotor abilities. Factor 4 (verbs) and Factor 5 (elements) appear to represent cognitive/psychomotor abilities associated with the Pilot occupational group. The remaining factors within both structures appear to be somewhat unique and relate abilities to individual or pairs of occupational groups (AFSs). Primary differences between the two factor structures tend to be associated with the efficiency with which occupational groups are discriminated. For example, the verbal factor associated with verbs (Factor 1) appears to distinguish between officer and enlisted personnel to a greater extent than the verbal factor associated with elements (Factor 2). Similarly, the quantitative reasoning factor associated with verbs (Factor 2) seems to distinguish between enlisted and officer personnel to a greater extent than the quantitative/reasoning factor associated with elements (Factor 1). The same can be said for Factor 3 of both structures. These differences may be a function of the broader, more general nature of the elements of the GWI, or a function of how the GWI was used in this study[14]. Since

[14] Only a subset of the 268 work elements contained in the complete GWI were used to elicit ability taxonomy importance ratings (see footnotes 4 and 5). This subset consisted primarily of Section B (Information Elements) and Section E (Physical Activities). Other subsets of the GWI such as Sensory requirements, General Mental Requirements, and Interpersonal Activities were not used, to avoid overlap with the abilities taxonomy. Logistical considerations also made it impossible to ask respondents to rate

the GWI approach (elements) appears to yield less distinct information relative to ability differences among occupational groups, remaining analysis efforts will focus primarily on the CODAP approach (verbs).

A gross comparison between the "verbs" factor structure and those factor structures reported for the Armed Services Vocational Aptitude Battery (ASVAB) (Welsh, Kucinkas, & Curran, 1990), Air Force Officer Qualifying Test (AFOQT) (Skinner & Ree, 1987), and Basic Attributes Test (BAT) (Carretta, 1990) can be summarized as follows. Carretta (1990) reported a six-factor solution for the BAT. Of these, factor one was defined by complex coordination tracking error scores; and factors three and four, as components of information processing speed. These three factors would seem to relate to Factor 4 of the "verbs" structure which tends to be characterized by Pilot-related abilities of Spatial Orientation, Time Sharing, Choice Reaction Time, and Information Ordering. However, Carretta's factor two (finger dexterity) appears unrelated to this "verbs" factor. Of the six AFOQT factors defined by Skinner and Ree (1987), "verbal", "quantitative", and "space perception" would seem to be related to Factors 1, 2, and 4, respectively, of the "verbs" structure. Of the "verbal," "speed," "technical," and "quantitative" factors comprising the current ASVAB versions (Welsh et al., 1990), verbal and quantitative factors are clearly represented within the "verbs" factor structure.

Primary differences are characterized by Factor 3 of the "verbs" structure, which is associated with psychomotor abilities such as Finger Dexterity, Arm-Hand Steadiness, and Static Strength, and has no comparable counterpart within either ASVAB-or AFOQT-reported factor structures. Although Factor 1 of the "verbs" structure is similar to the verbal factors of the ASVAB and AFOQT, its focus appears to be more narrow. Factor 1 of "verbs" tends to be highly related to the Verbal Expression ability. Verbal factors associated with ASVAB and AFOQT tend to be somewhat broader and defined in terms of Word Knowledge (WK) and Paragraph Comprehension (PC), and of Verbal Analogies, Reading Comprehension, and Word Knowledge, respectively.

Ability Mean Comparisons

An examination of differences in mean ability importance ratings[15] for the eight occupational groups (Table 11) tends to show a number of meaningful differences. On the officer side, the above average cognitive and psychomotor ability pattern depicted for the Pilot specialty appears to be highly appropriate in that high importance is assigned to those abilities

each of 268 elements with respect to ability importance. If all 268 work elements had been used, it is possible that the factor structure associated with elements would have been different from the one described above.

[15] The mean ability ratings contained in Table 11 are limited to those values that exceed the grand mean for a given ability by .5 or greater. These values represent raw means. The use of raw mean values as opposed to standardized values is considered appropriate given the "absolute" nature of the rating scale used.

that one would expect to be fundamental for flying aircraft. A comparison of these Pilot abilities with those of the nonflying officer specialties[16] also reflects logical differences. Nonrated officers appear to feel that cognitive and interpersonal abilities such as Verbal Expression, Persuading/Influencing, Assuming Responsibility, Empathy, Verbal Comprehension, and Originality are important. This set of abilities rated high by nonflying personnel seem to be extremely important for effective performance of Air Force officers in general. It should be noted that among these abilities, Originality, Persuading/Influencing, Assuming Responsibility, and Empathy are not directly assessed by current officer selection measures.

Mean ability importance ratings among the four enlisted specialties are even more distinct. The AFS 271X2 (Operations Resources Management) ability importance ratings pattern reflects a strong numerical/speed orientation characterized by high ability ratings with respect to Number Facility, reasoning, and speed. These abilities are quite similar to those associated with the Administrative (A45) aptitude requirement of this AFS.[17] The AFS 411X2A (Missile Facilities Maintenance) mean ability importance ratings pattern is essentially psychomotor in nature. The abilities rated as important (Static Strength, Finger Dexterity, Arm-Hand Steadiness, and Multilimb Coordination) appear to have little in common with the Electronics composite[18] (E33) used to select personnel into this career field. The high strength aptitude (K/70 lbs) associated with this specialty does, however, relate to the high rating on the Static Strength ability. Given that AFS 411X2A is the only true "maintenance" specialty contained in the sample of occupational groups used for this study, it is not surprising that high psychomotor ability ratings distinguish this occupational group from the others. It also should be noted that these psychomotor abilities are not currently measured by the ASVAB. AFS 924X0 (Medical Laboratory) is best characterized

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[16] The X-Prefix occupational inventory used with this study contained those duties and tasks associated with safety/accident investigation activities, not flying activities.

[17] Administrative (A) is a composite of NO (Numerical Operations), CS (Coding Speed) and VE (Verbal Expression).

[18] E is composed of AR (Arithmetic Reasoning), MK (Mathematics Knowledge), EI (Electronics Information), and GS (General Science) ASVAB Subtest Scores.

Table 11. Ability Means Characterizing the Eight Occupational Groups

ABILITIES	GRAND MEAN	OFFICER AFSs				ENLISTED AFSs			
		X-PREFIX	PILOT	49XX	70XX	271X2 (A45)	411X2A (E33)	464X0 (M60/ E46)	924X0 (G43)
1. Verbal Comprehension	5.2			6.1	5.7			6.0	
2. Verbal Expression	4.5	5.6		6.0	5.9				
3. Number Facility	2.9		3.4			4.1		4.4	
4. Mathematical Reasoning	2.6			3.1		3.6		4.0	
5. Inductive Reasoning	3.8			4.5		4.4		4.9	
6. Deductive Reasoning	4.3		4.8	4.8				5.7	
7. Memorization	3.2		4.3			4.2		5.1	
8. Information Ordering	4.3		5.0			4.8		5.5	
9. Time-Sharing	3.1		5.0			3.7		4.5	
10. Flexibility of Closure	2.2		3.9					3.7	
11. Speed of Closure	2.4		4.6			3.1		3.9	
12. Perceptual Speed	2.6		5.0			3.6		3.9	
13. Spatial Orientation	2.3		5.5					4.1	
14. Visualization	2.8		5.4					4.2	
15. Originality	2.5	3.4		3.3				4.4	
16. Static Strength	1.4						2.5	3.5	
17. Finger Dexterity	2.2						3.9	4.2	2.7
18. Arm-Hand Steadiness	2.0		2.6				3.8	4.2	
19. Multilimb Coordination	1.9		3.0				3.1	4.0	
20. Choice Reaction Time	2.2		4.4					4.0	
21. Rate Control	1.5		3.5					2.9	
22. Persuading/Influencing	2.7	4.3		4.5	3.8			3.3	
23. Cooperating	3.5			4.5				4.6	
24. Assuming Responsibility	4.0	4.7		5.1	4.7			4.9	
25. Working Effectively in Isolation Settings	2.1							3.8	
26. Working Effectively in Uncomfortable Human Situations	2.9		3.7					4.8	
27. Empathy	1.9	2.7		2.4	3.0				
28. Self-Assessing	2.7		3.8					3.4	

by the absence of any meaningful ability pattern (only Finger Dexterity appears to have above average-importance). The General (G43) aptitude requirement associated with this specialty tends to some extent to support this nonpattern finding. AFS 464X0 (Explosive Ordnance Disposal), on the other hand, is characterized by a pattern of above-average ability importance ratings across the spectrum of cognitive, psychomotor, and interpersonal abilities. Given the complex nature of the aptitude requirements needed for entry into this career field (M60 and E46), this pattern of obtained ability importance ratings is not surprising.

Profiles (Figure 1) of mean ability importance ratings for Pilot, officer specialties (X-Prefix, 49XX, and 70XX), and enlisted specialties are also as one would expect. Officer ability patterns tend to be higher with respect to verbal and selected interpersonal abilities, and low with respect to psychomotor and selected spatial and perceptual cognitive abilities. Enlisted specialties tend to differ from officer specialties on verbal (lower) and psychomotor (higher) abilities. Pilot remains distinct chiefly as a result of the importance of those cognitive and psychomotor abilities related to flying.

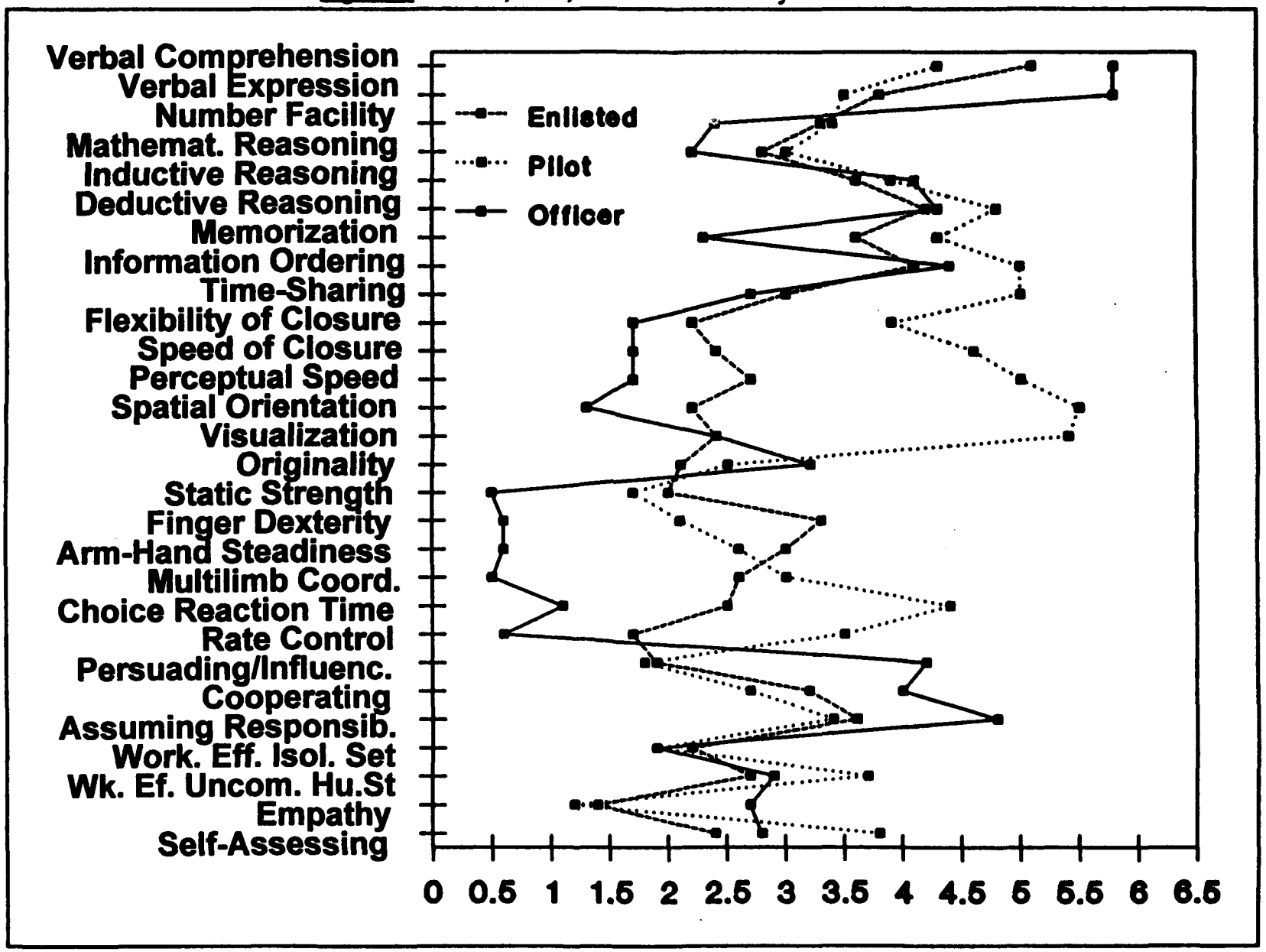
The profiles may also be interpreted in light of scales. The middle score, 5, is a level of ability required of the average high school graduate for enlisteds (college for officers) given adequate training and experience. Verbal Comprehension had a mean rating of 5.1 for enlisted and 5.8 for officers, and Verbal Expression had a mean rating of 5.8 for officers. All fifty-three other mean ratings were below a score of 5.

Cluster Analysis

As an adjunct to the factor analysis performed on the "verbs" and "elements" data sets, and to obtain a clearer indication of the extent to which like verbs and elements tended to group together, the Comprehensive Occupational Data Analysis Programs (CODAP) programs OVRLAP, GROUP, and DIAGRM were used to compute and map cluster solutions for the verbs and elements data sets. Specifically, OVRLAP was used to calculate overlap values for ability importance ratings for each pair of verbs or elements. The resulting similarity matrix of overlap values was then clustered using GROUP. DIAGRM was used to map the resulting solutions. Figure 2 is the "verbs" cluster solution, and Figure 3 is the solution for elements.

The verbs cluster solution (Figure 2) can best be described specifically in terms of seven major groups encompassing six stages. Stage 14 (I and II) tends to include the nonrated officer group (X-Prefix, 49XX, and 70XX). This stage is characterized by high Verbal Expression and Verbal Comprehension ability importance ratings and corresponds to the officer profile depicted in Figure 1. Verbs such as Write/Draft, Prepare, Review, Develop, and Conduct group together and account for approximately one-half of the 30 verbs associated with this stage. Stage 19 (III) includes most of the verbs associated with the Pilot specialty and is characterized by high Spatial Orientation and Visualization ability

Figure 1. Officer, Pilot, and Enlisted Ability Mean Profiles



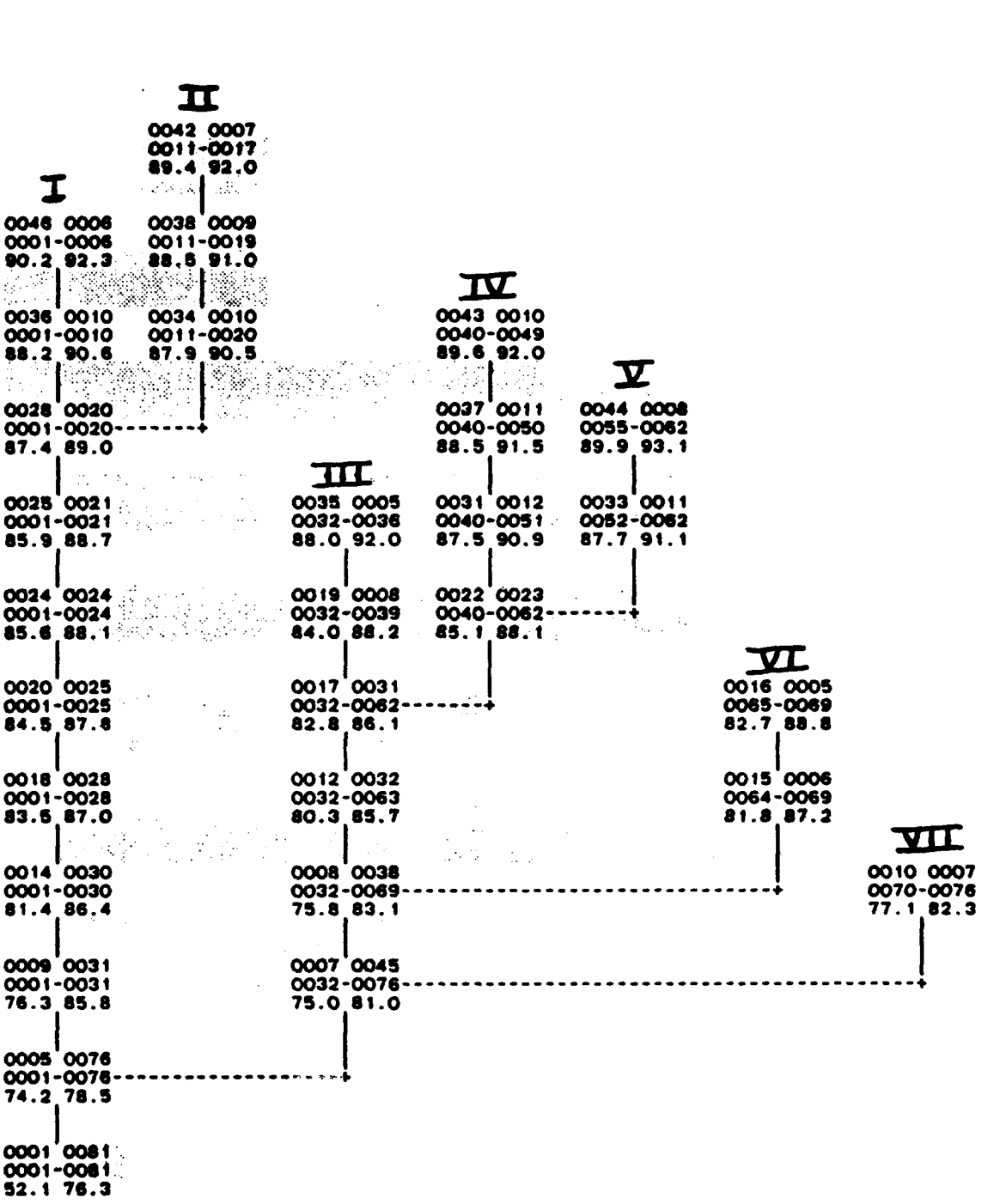


Figure 2. Cluster Solution for Verbs

1.	1	X-PREFIX, Conduct
2.	2	X-PREFIX, Coordinate
3.	21	49XX, Conduct
4.	24	49XX, Establish
5.	26	49XX, Participate
6.	28	49XX, Provide
7.	3	X-PREFIX, Develop
8.	5	X-PREFIX, Evaluate
9.	22	49XX, Determine
10.	23	49XX, Develop
11.	8	X-PREFIX, Prepare
12.	10	X-PREFIX, Write
13.	31	70XX, Advise
14.	30	49XX, Write
15.	35	70XX, Develop
16.	38	70XX, Plan
17.	36	70XX, Draft
18.	27	49XX, Prepare
19.	39	70XX, Prepare
20.	34	70XX, Coordinate
21.	40	70XX, Review
22.	7	X-PREFIX, Obtain
23.	32	70XX, Approve
24.	33	70XX, Conduct
25.	4	X-PREFIX, Ensure
26.	6	X-PREFIX, Maintain
27.	25	49XX, Maintain
28.	37	70XX, Monitor
29.	9	X-PREFIX, Review
30.	29	49XX, Review
31.	76	924XO, Notify
32.	11	PILOT, Accomplish
33.	15	PILOT, Fly
34.	19	PILOT, Perform
35.	17	PILOT, Maintain
36.	18	PILOT, Make
37.	12	PILOT, Analyze
38.	13	PILOT, Apply
39.	16	PILOT, Interpret
40.	41	271X2, Audit
41.	46	271X2, Perform
42.	70	464XO, Research
43.	44	271X2, Maintain
44.	65	464XO, Maintain
45.	45	271X2, Monitor
46.	47	271X2, Prepare
47.	48	271X2, Request
48.	49	271X2, Update
49.	50	271X2, Verify
50.	43	271X2, Input
51.	42	271X2, Coordinate
52.	53	411X2A, Inspect
53.	57	411X2A, Ops Ck
54.	60	411X2A, Troubleshoot
55.	61	464XO, Determine
56.	64	464XO, Inspect
57.	62	464XO, Dispose
58.	68	464XO, Prepare
59.	67	464XO, Perform
60.	69	464XO, Render Safe
61.	63	464XO, Initiate
62.	66	464XO, Operate
63.	20	PILOT, Recognize
64.	51	411X2A, Adjust
65.	52	411X2A, Dispose
66.	54	411X2A, Install
67.	58	411X2A, Remove
68.	59	411X2A, Service
69.	78	924XO, Prepare
70.	55	411X2A, Maintain
71.	56	411X2A, Make Entries
72.	75	924XO, Maintain
73.	74	924XO, Identify
74.	77	924XO, Perform
75.	80	924XO, Run
76.	79	924XO, Record
77.	14	PILOT, Estimate
78.	72	924XO, Clean
79.	81	924XO, Stain
80.	73	924XO, Draw
81.	71	924XO, Calculate

Figure 2. Cluster Solution for Verbs (Continued)

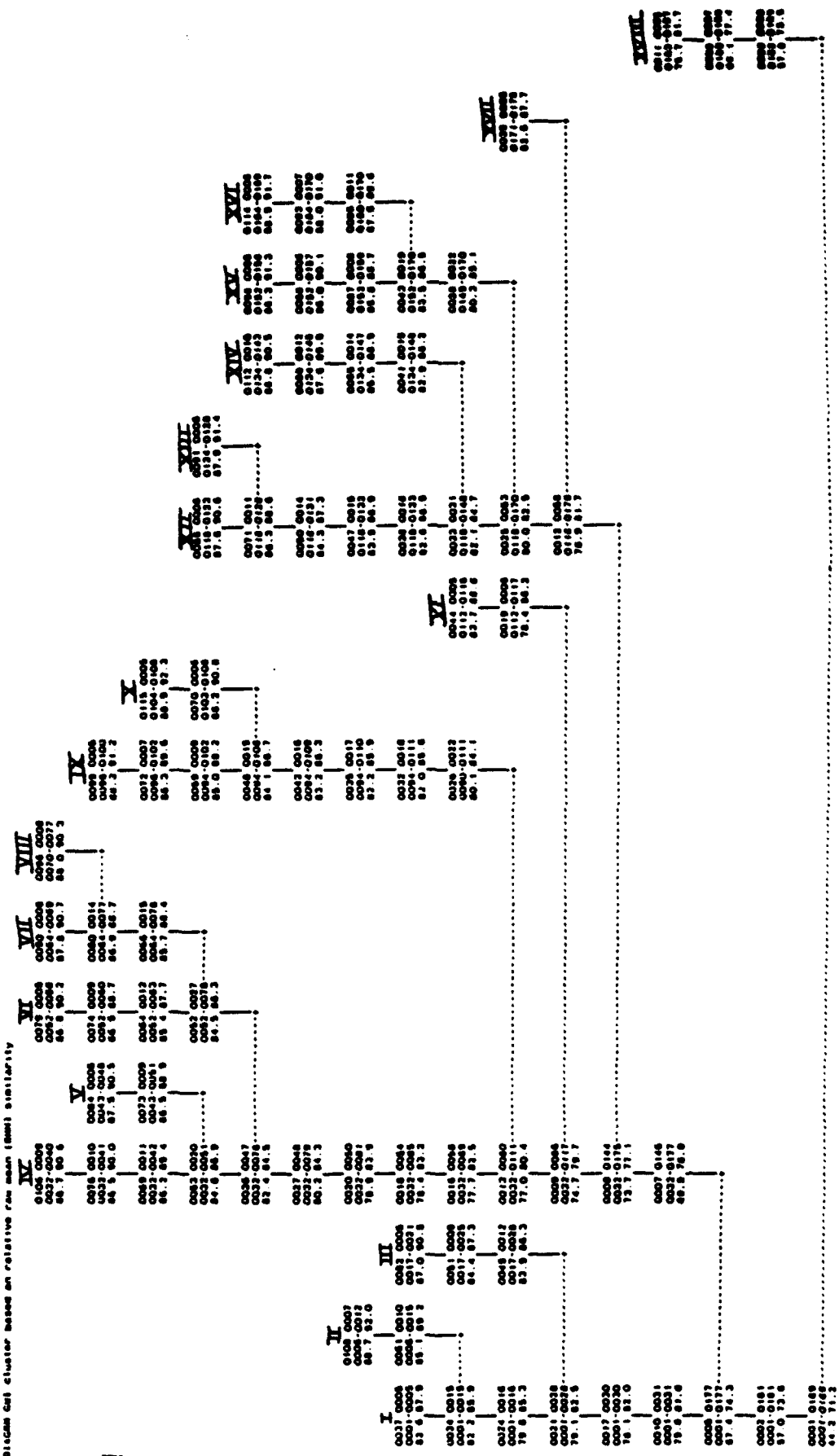


Figure 3. Cluster Solution for Elements

1. 1 X-PREFIX, E130
2. 26 PILOT, E130
3. 133 411X2A, E173
4. 129 411X2A, E127
5. 137 411X2A, E159
6. 114 271X2, E117
7. 123 411X2A, E169
8. 125 411X2A, E165
9. 132 411X2A, E161
10. 136 411X2A, E160
11. 126 411X2A, E114
12. 128 411X2A, E122
13. 130 411X2A, E174
14. 135 411X2A, B30
15. 138 411X2A, E113
16. 181 924XO, E176
17. 8 X-PREFIX, E112
18. 182 924XO, E114
19. 28 PILOT, E112
20. 43 PILOT, E122
21. 58 49XX, E113
22. 55 49XX, E116
23. 70 49XX, E117
24. 170 924XO, E119
25. 187 924XO, E116
26. 85 70XX, E113
27. 92 70XX, E117
28. 93 70XX, E116
29. 10 X-PREFIX, E122
30. 53 49XX, E122
31. 158 464XO, B35
32. 2 X-PREFIX, B15
33. 35 PILOT, B26
34. 46 PILOT, B37
35. 39 PILOT, B17
36. 42 PILOT, B13
37. 36 PILOT, B16
38. 40 PILOT, B69
39. 37 PILOT, B12
40. 38 PILOT, B14
41. 12 X-PREFIX, B17
42. 172 924XO, B15
43. 11 X-PREFIX, B173
44. 15 X-PREFIX, B26
45. 14 X-PREFIX, B12
46. 94 70XX, B14
47. 16 X-PREFIX, B14
48. 64 49XX, B14
49. 18 X-PREFIX, B16
50. 19 X-PREFIX, B37
51. 110 271X2, B14
52. 5 X-PREFIX, B18
53. 23 X-PREFIX, B13
54. 52 49XX, B18
55. 67 49XX, B24
56. 74 70XX, B18
57. 57 49XX, B26
58. 175 924XO, B26
59. 150 464XO, B26
60. 115 411X2A, B18
61. 178 924XO, B71
62. 180 924XO, B13
63. 183 924XO, B24
64. 9 X-PREFIX, B10
65. 51 49XX, B10
66. 100 271X2, B18
67. 102 271X2, B24
68. 141 464XO, B10
69. 142 464XO, B11
70. 32 PILOT, B18
71. 33 PILOT, B10
72. 116 411X2A, B10
73. 66 49XX, B63
74. 77 70XX, B63
75. 81 70XX, B24
76. 83 70XX, B26
77. 105 271X2, B26
78. 118 411X2A, B11
79. 153 464XO, B73
80. 68 49XX, B16
81. 151 464XO, B16
82. 140 464XO, B18
83. 144 464XO, B21
84. 154 464XO, B22
85. 157 464XO, B24
86. 161 464XO, B13
87. 167 924XO, B10
88. 173 924XO, B47
89. 168 924XO, B18
90. 4 X-PREFIX, E173
91. 27 PILOT, B15
92. 29 PILOT, E173
93. 184 924XO, E173
94. 21 X-PREFIX, B30
95. 24 X-PREFIX, E115
96. 44 PILOT, E115
97. 177 924XO, B30
98. 179 924XO, E115
99. 50 49XX, E115
100. 88 70XX, B30
101. 95 271X2, B30
102. 96 271X2, E115
103. 41 PILOT, E174
104. 117 411X2A, B37
105. 119 411X2A, B39
106. 122 411X2A, B15
107. 120 411X2A, E168
108. 127 411X2A, B16
109. 185 924XO, B35
110. 145 464XO, B37
111. 156 464XO, B15
112. 61 49XX, B12
113. 69 49XX, B29
114. 174 924XO, B12
115. 109 271X2, B29
116. 113 271X2, B12
117. 160 464XO, B12
118. 3 X-PREFIX, B11
119. 31 PILOT, B11
120. 155 464XO, B63
121. 48 PILOT, B53
122. 71 70XX, B11
123. 72 70XX, B10
124. 89 70XX, B65
125. 90 70XX, B55
126. 91 70XX, B33
127. 99 271X2, B10
128. 111 271X2, B63
129. 20 X-PREFIX, B53
130. 112 271X2, B53
131. 80 70XX, B53
132. 166 924XO, B11
133. 54 49XX, B11
134. 6 X-PREFIX, B19
135. 13 X-PREFIX, B20
136. 45 PILOT, B20
137. 121 411X2A, B19
138. 56 49XX, B19
139. 73 70XX, B19
140. 82 70XX, B54
141. 84 70XX, B20
142. 98 271X2, B19
143. 106 271X2, B20
144. 34 PILOT, B19
145. 59 49XX, B20
146. 97 271X2, B11
147. 163 464XO, B64
148. 165 924XO, B19
149. 17 X-PREFIX, E174
150. 25 X-PREFIX, B33
151. 188 924XO, E174
152. 22 X-PREFIX, B21
153. 79 70XX, B21
154. 76 70XX, B64
155. 131 411X2A, B21
156. 134 411X2A, B22
157. 103 271X2, B21
158. 60 49XX, B21
159. 176 924XO, B21
160. 49 PILOT, B22
161. 108 271X2, B22
162. 104 271X2, B25
163. 107 271X2, B27
164. 62 49XX, B22
165. 63 49XX, B27
166. 65 49XX, B25
167. 78 70XX, B22
168. 86 70XX, B27
169. 87 70XX, B25
170. 189 924XO, B22
171. 7 X-PREFIX, E113
172. 30 PILOT, E113
173. 47 PILOT, B21
174. 101 271X2, E113
175. 149 464XO, E113
176. 152 464XO, B30
177. 162 464XO, E115
178. 143 464XO, B19
179. 146 464XO, B20
180. 186 924XO, B20
181. 164 464XO, B53
182. 75 70XX, E122
183. 124 411X2A, E108
184. 139 411X2A, E156
185. 147 464XO, E108
186. 169 924XO, E122
187. 171 924XO, E133
188. 148 464XO, E127
189. 159 464XO, E128

Figure 3. Cluster Solution for Elements (Continued)

importance ratings. Stage 31 (IV) is dominated by verbs associated with AFS 271X2; and Stage 44 (V), by verbs associated with AFS 464X0. These two stages are similar with respect to high Verbal Comprehension, Deductive Reasoning, and Information Ordering ability importance ratings. They tend to differ with respect to the relatively high importance assigned by AFS 464X0 personnel to the Working Effectively in Uncomfortable Human situations. Stage 15 (VI) is characterized by verbs related to AFS 411X2A and relatively high importance ratings on psychomotor abilities (Arm-Hand Steadiness, Finger Dexterity, and Multilimb Coordination). Stage 10 (VII) is loosely related to AFS 924X0 verbs and does not appear to be characterized by any distinct ability importance pattern. In gross terms, the verbs cluster solution can be described in terms of Stage 14 (Verbal Expression, Verbal Comprehension, Assuming Responsibility) containing verbs associated with nonrated officers, and Stage 7 (Verbal Comprehension, Information Ordering, Deductive Reasoning) containing verbs associated with the remaining five occupational groups. Only in Stage 14 does there appear to be consistent grouping of like verbs. Overall, the cluster solution appears to be driven more by occupational group ability importance differences than by ability importance similarities associated with like verbs.

The element cluster solution (Figure 3) can be described in terms of eighteen groups encompassing six stages. Stage 21 (I, II, and III) contains elements that received high importance ratings on psychomotor abilities such as Finger Dexterity and Arm-Hand Steadiness. Elements associated with this stage tend to be those related to operating or maintaining equipment ranging from flying vehicles to office equipment. Stage 36 (IV through VIII) includes elements rated high on reasoning abilities and Verbal Comprehension. Elements represent those associated with understanding and evaluating written information. Stage 48 (IX and X) contains elements with relatively high importance ratings on a set of cognitive and psychomotor abilities (Reasoning, Verbal Comprehension, Finger Dexterity, Information Ordering). Included elements are related to using mechanical and electronic information, and operating data processing devices such as computers. Stage 19 (XI) contains a set of relatively unique elements involving the use of mathematical information to solve numerical problems. These elements are characterized by high importance ratings on Mathematical Reasoning, Number Facility, and Deductive Reasoning. Stage 12 (XII through XVII) incorporates elements that received high importance ratings on verbal abilities (Verbal Expression and Verbal Comprehension). These elements have to do with the organization and use of verbal materials and their production. Stage 11 (XVIII) tends to be associated with elements related to the use of tools and is characterized by high importance ratings on psychomotor abilities (Finger Dexterity, Arm-Hand Steadiness, and Multilimb Coordination). Overall, like elements appear to be more closely related than were verbs (Figure 2). However, element groupings did not seem to represent clear patterns of occupational group differences to the extent noted for verbs.

Comparison of Ability Levels

Section II of both survey booklet versions (CODAP and GWI) required incumbents to use a 7-point scale (7 = Very High Ability Level, 1 = Very Low Ability Level) to rate the degree to which each of the 28 abilities comprising the taxonomy was possessed by selected groups (average college graduate and fully qualified officer for officer specialties; and average high school graduate and journeyman for enlisted specialties). Evaluation of ability-level differences between the designated groups within each specialty indicated that the greatest ability-level differences occurred for Assuming Responsibility and Working Effectively in Uncomfortable Human Situations. This finding was consistent across both survey versions and occupational groups. These two interpersonal abilities[19] are not currently measured by existing selection/classification instruments.

V. DISCUSSION

This study was designed to assess four fundamental questions. The first dealt with the degree to which reliable ability importance ratings could be obtained from subject-matter experts via survey mailout. The second concerned the extent to which the obtained ability importance ratings differentiated among the eight occupational groups, and the validity of the resulting rating patterns. The third area of investigation centered on the degree to which identical verbs and GWI elements tended to represent similar ability sets. The final question addressed the comparability of ability requirements derived from the CODAP-based (verbs) and GWI-based (elements) approaches.

Obtained rater reliabilities were satisfactory. Median R_{KK} values (interrater reliabilities for each composite of N raters) ranged from .88 to .97, with all but three at least .90. These results indicate that reliable ability importance information can be obtained from subject-matter experts using survey methodology. These findings also imply that survey booklet formats and the associated 9-point importance-of-ability scale functioned properly. The reported survey return rate across occupational groups of 32 percent indicated that survey completion was not overly burdensome for survey respondents, especially given mailout timing (i.e., during holiday periods).

Ability importance ratings based on verbs (CODAP approach) seemed to clearly differentiate among occupational groups; the GWI approach appeared to be less effective at this differentiation. Analysis of mean importance ratings based on verbs yielded distinct ability patterns across occupational groups and between sets of occupational groups. Among the

[19] R_{11} values for differences ranged from .10 for AFS 271X2 (Verbs) to .42 for AFS 70XX (Verbs), with a median of .20.

officer specialties, differences in ability importance ratings were noted between rated and nonrated specialties. Clear differences were also detected among the enlisted specialties, and between the sets of officer and enlisted specialties. More importantly, the obtained pattern of ability ratings for each occupational group appeared to have at least face validity. Additionally, sets of psychomotor, interpersonal and cognitive abilities not currently measured by the ASVAB or AFOQT were identified among those abilities rated as important for successful performance within occupational groups.

Evaluation of both factor and cluster analysis solutions for verbs (CODAP-based), tended to show some grouping of like verbs with respect to specific abilities (e.g., "write" and "draft" were associated with a verbal ability factor, and "audit" and "calculate" were associated with a quantitative factor). For the most part, however, the cluster solution tended to be driven by occupational group differences. On the other hand, there appeared to be a greater tendency for like elements (GWI-based) to group together with respect to specific abilities. This is probably a function of the broad nature of the element task statements used and the high frequency of element overlap across occupational groups. Additionally, the absence of strong differentiation among occupational groups for the GWI approach may have tended to facilitate the grouping of like elements.

Although CODAP-based (verbs) and GWI-based (elements) data sets tended to yield comparable factor structures, the extent to which occupational groups were differentiated by these two approaches was markedly different. Ability importance patterns based on "verbs" clearly distinguished occupational groups. Distinctions in ability importance patterns based on "elements" were minimal. The "less clear" occupational distinctions associated with the GWI-based approach may be a function of the broad nature of the element statements used, or a function of eliciting ability importance ratings on restricted subsets of GWI elements (using the complete set of 268 elements would have been logistically impossible). Whatever the cause, the GWI approach does not seem to be a suitable substitute for the CODAP-based approach if we assume that differing jobs indeed require differing abilities for their successful accomplishment.

VI. RECOMMENDATIONS FOR FUTURE RESEARCH

Based on study results, continuation of this line of research appears to be merited. This future research should focus on the enhancement and broader application of the CODAP-based approach.

Among those research areas requiring further investigation is the role of task statement objects (focus of action verbs) and associated task factor data in distinguishing meaningful levels of specific abilities required for successful performance within and across occupational

groups. Current study results indicate that verbs can be used to elicit meaningful data with respect to abilities required for occupational groups. What is unknown at this point is how much (what level) of any given ability is necessary for successful performance. Eliciting ability ratings from verbs matched with selected sets of objects may yield the level-of-ability information required. For example, successfully troubleshooting an inertial navigation system may require more reasoning ability than troubleshooting an electrical relay. Within an occupational group, this should not be difficult to assess. However, determining differences in reasoning ability level needed to troubleshoot an inertial navigation system as opposed to a fuels system involves comparisons across occupational groups and is a much more complex issue. Comparisons of this type require a common metric such as that used to make task learning difficulty comparisons (benchmark learning difficulty) among specialties. It is possible that the benchmark learning difficulty indices associated with selected object sets can be used to provide further insight into differences in ability-level requirements across specialties.

An alternative approach to assessing differences in required ability levels involves the relationship between verb/object sets and the underlying knowledges required for successful performance. It may be more practical to identify categories of knowledges required to perform verb/object sets and then relate the knowledge categories to ability-level differences. The methodologies for linking verb/object combinations to knowledge taxonomies have been developed and successfully tested in concurrent Laboratory research efforts.

Given that only one true "maintenance" specialty (AFS 411X2A) was included among the occupational groups surveyed as part of this current research, future field testing should be expanded to encompass a much wider range of specialties. At a minimum, a number of aircraft maintenance specialties from both electronics and mechanical aptitude areas should be studied and compared with respect to ability requirements.

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APPENDIX A

SET OF 28 ABILITIES AND MODIFIED DEFINITIONS

1. VERBAL COMPREHENSION

This is the ability to understand language, both individual words as well as words as they appear in sentences and paragraphs.

EXAMPLES:
(1) Understand a mortgage contract for a new home (HIGH LEVEL).

(2) Understand a newspaper article in the society section reporting on a recent party (MODERATE LEVEL).

(3) Understand a comic book (LOW LEVEL).

2. VERBAL EXPRESSION

This is the ability to use language (either oral or written) to communicate information or ideas to other people.

EXAMPLES:
(1) Write a Pulitzer prize novel (HIGH LEVEL).

(2) Write a job recommendation for a subordinate (MODERATE LEVEL).

(3) Cancel newspaper delivery by telephone (LOW LEVEL).

3. NUMBER FACILITY

This is the ability to perform numerical operations quickly and accurately; for example, add, subtract, multiply, and divide.

EXAMPLES:
(1) Compute the volume of coal ore in portions of a mine using survey notes (HIGH LEVEL).

(2) Check accuracy of restaurant bill against the prices listed in the menu and then recompute the bill (MODERATE LEVEL).

(3) Add 2 and 7 (LOW LEVEL).

4. MATHEMATICAL REASONING

This is the ability to reason abstractly using mathematical concepts and symbols in order to change a problem described in words into a solvable mathematical equation.

EXAMPLES:
(1) Determine mathematics for simulating a lunar approach and landing (HIGH LEVEL).

(2) Review farm production records to determine appropriate summary statistics (MODERATE LEVEL).

(3) As a cashier in a dime store, understand how to "make change" (LOW LEVEL).

5. INDUCTIVE REASONING

This is the ability to find the most appropriate general concepts or rules which fit sets of data or which explain how a given series of individual items are related to each other. It involves the ability to logically proceed from individual cases to general principles.

EXAMPLES:
(1) Develop a model reflecting all of the factors which contribute to presidential election results (HIGH LEVEL).

(2) Forecast manpower or material needs of a growing pharmaceutical company based on past performance (MODERATE LEVEL).

(3) Given a set of books to arrange, one determines the best system is fiction and non-fiction (LOW LEVEL).

6. DEDUCTIVE REASONING

This is the ability to apply general concepts or rules to specific cases or to proceed from stated premises to their logical conclusions.

EXAMPLES:
(1) Design an aircraft wing using the principles of aerodynamics (HIGH LEVEL).

(2) What factors you would take into account planning your vacation to Mexico (MODERATE LEVEL).

(3) Decide whether or not to take an umbrella (LOW LEVEL).

7. MEMORIZATION

This is the ability to memorize and retain new information which occurs as a regular or routine part of the task.

EXAMPLES:

(1) After examining 21 pictures of common objects, each paired with a 2-digit number for 4 minutes, write the appropriate number under each picture when they are presented in a different order (HIGH LEVEL).

(2) Memorize the names and locations of all the African countries so that when an outline map is presented, the countries can be correctly labeled (MODERATE LEVEL).

(3) Memorize a 3-digit combination for a gym locker, including both the numbers and direction (LOW LEVEL).

8. INFORMATION ORDERING

This is the ability to apply rules in order to arrange information into the best or most appropriate sequence. The types of information considered under this ability include numbers, letters, words, pictures, procedures, sentences, and mathematical or logical operations.

EXAMPLES:

(1) Determine the appropriate sequence of checkout procedures for the Apollo rocket (HIGH LEVEL).

(2) Outline the schedule of work for a housing project, given a list of activities to be done (MODERATE LEVEL).

(3) Arrange a group of people by height (LOW LEVEL).

9. TIME-SHARING

This is the ability to shift between two or more sources of information. The information obtained from these sources is either combined and used as a whole, or is retained and used separately.

EXAMPLES:

(1) Air traffic controller monitors radar scope to keep track of inbound and outbound planes during a period of heavy, congested traffic (HIGH LEVEL).

(2) Playground director supervises 50 children who are engaging in many different activities (MODERATE LEVEL).

(3) A short stop watches the lead of the runner on second and actions of the pitcher (LOW LEVEL).

10. FLEXIBILITY OF CLOSURE

This is the ability to "hold in mind" a particular visual pattern and then find it embedded in distracting material.

EXAMPLES:

(1) Spot a chameleon in high grass (HIGH LEVEL).

(2) Find 5 camouflaged birds in a picture (MODERATE LEVEL).

(3) Upon arriving at a cocktail party, visually identify your friends (LOW LEVEL).

11. SPEED OF CLOSURE

This is the ability to quickly combine and organize a set of apparently different elements into a single, meaningful pattern or configuration.

EXAMPLES:

(1) Process information concerning an unidentified aircraft in air defense systems (HIGH LEVEL).

(2) When presented with 10 drawings, each containing parts of an object being portrayed (e.g., a camera), write down the name of each of the 10 objects (Time limit - 3 minutes) (MODERATE LEVEL).

(3) While listening to the radio, recognize and start to hum an "oldie" after hearing the first few notes (LOW LEVEL).

12. PERCEPTUAL SPEED

This is the ability to quickly find figures, make comparisons, or carry out other tasks involving visual perception.

EXAMPLES:

(1) Review 25 purchase requests in 2 minutes to ensure that a purchase order number is included on each form (HIGH LEVEL).

(2) Estimate the diameters of 20 logs to the nearest 1/2 foot in 10 minutes in order to set the saw speed (MODERATE LEVEL).

(3) Nursery man makes 25 fairly easy, gross estimates of distance before planting 25 shrubs to be evenly spaced every 3 to 4 feet (LOW LEVEL).

13. SPATIAL ORIENTATION

This is the ability to maintain orientation with respect to objects in space or to comprehend the position of objects in space with respect to your position.

EXAMPLES:

(1) Be aware of your orientation upon awakening in a gravity-free environment (e.g., space craft in orbit) (HIGH LEVEL).

(2) Use a road map to find your way through a major city (e.g., Boston), given that you have never been there before (MODERATE LEVEL).

(3) Locate specific constellations in the sky (LOW LEVEL).

14. VISUALIZATION

This is the ability to manipulate or transform the visual images of spatial patterns or objects into other spatial arrangements.

EXAMPLES:

(1) Design a new building for a college campus, determining how well it would go with and complement the other architectural styles on campus (HIGH LEVEL).

(2) Imagine what your living room would look like if you wanted to rearrange the furniture (MODERATE LEVEL).

(3) Imagine how to put paper in the typewriter so the letterhead is at the top (LOW LEVEL).

15. ORIGINALITY

This is the ability to produce unusual or clever responses related to a given topic or situation or to improvise solutions to problems or to develop procedures in situations where standard operating procedures do not apply.

EXAMPLES: (1) Research chemist invents new synthetic fiber (HIGH LEVEL).

(2) Design a bookcase using only bricks and boards so that it is both attractive and functional (MODERATE LEVEL).

(3) Auto mechanic adjusts the carburetor idle by using a dime in absence of a screwdriver, after co-worker suggested something thin (LOW LEVEL).

16. STATIC STRENGTH

This is the ability to exert muscular force against fairly immovable or heavy external objects in order to lift, push, or pull that object.

EXAMPLES: (1) Load 5 full 50-gallon oil drums into a truck (HIGH LEVEL).

(2) Push a stalled car to the side of the road (MODERATE LEVEL).

(3) Push an empty shopping cart (LOW LEVEL).

17. FINGER DEXTERITY

This is the ability to make skillful, coordinated movements of the fingers where manipulations of objects may or may not be involved.

EXAMPLES: (1) Play a classical flamenco piece on the guitar (HIGH LEVEL).

(2) String a badminton racket with new strings (MODERATE LEVEL).

(3) Put coins in a parking meter (LOW LEVEL).

18. ARM-HAND STEADINESS

This is the ability to make precise, steady arm-hand positioning movements where both strength and speed are minimized.

EXAMPLES: (1) Surgeon makes an incision into the heart (HIGH LEVEL).

(2) Pluck eyebrows (MODERATE LEVEL).

(3) Point at a sign (LOW LEVEL).

19. MULTILIMB COORDINATION

This is the ability to coordinate the movements of two or more limbs (e.g., two legs, two hands, one leg, and one hand).

EXAMPLES: (1) Juggle 3 rubber balls (HIGH LEVEL).

(2) Knit a sweater (MODERATE LEVEL).

(3) Clap your hands (LOW LEVEL).

20. CHOICE REACTION TIME

This is the ability to quickly pick the right action that goes with a given condition when several different actions can be selected.

EXAMPLES: (1) In a space craft out of control, an astronaut has time to choose only 1 of 5 possible corrective actions in two-thirds of a second (HIGH LEVEL).

(2) Operate a busy switchboard where you start to answer each call in 1 second on the average (MODERATE LEVEL).

(3) Select the correct fork in the road when the road sign is located at the center of the fork itself and where you have 1 second to make your choice (LOW LEVEL).

21. RATE CONTROL

This is the ability to make timed, anticipatory muscular movements to intercept or follow a continuously moving object whose speed and/or direction vary in an unpredictable fashion.

EXAMPLES:
(1) Use a highly sensitive control knob to keep a 2-inch circle around a target which varies in speed and direction on a TV screen (HIGH LEVEL).

(2) Adjust your rhythm of work to the conveyor belt speed which randomly varies in speed from 1 to 3 inches per second (MODERATE LEVEL).

(3) Ride a bicycle alongside a runner (LOW LEVEL).

22. PERSUADING/INFLUENCING

This is the ability to get others to think or act as you would like them to, without force or coercion.

EXAMPLES:
(1) Convince a jury that your client is innocent (HIGH LEVEL).

(2) Lobby a state legislator for a new law (MODERATE LEVEL).

(3) Change a friend's mind about attending a social function (LOW LEVEL).

23. COOPERATING

This is the ability to work with others in a cooperative manner to complete tasks or achieve goals within both small-and large-group settings requiring teamwork.

EXAMPLES:
(1) Co-author a book or technical report (HIGH LEVEL).

(2) Serve as a member on a staff committee (MODERATE LEVEL).

(3) Work as a member of a crew (LOW LEVEL).

24. ASSUMING RESPONSIBILITY

This is the ability to assume responsibility for the productivity, behavior, or well-being of others.

EXAMPLES: (1) Being responsible for the well-being and productivity of a large group of personnel (HIGH LEVEL).

(2) Being a team leader (MODERATE LEVEL).

(3) Accepting responsibility for one's own behavior (LOW LEVEL).

25. WORKING EFFECTIVELY IN ISOLATION SETTINGS

This is the ability to work productively in limited personal contact situations.

EXAMPLES: (1) Manning an isolated listening post for a 30-day period (HIGH LEVEL).

(2) Guarding aircraft on a flight line (MODERATE LEVEL).

(3) Driving a truck alone (LOW LEVEL).

26. WORKING EFFECTIVELY IN UNCOMFORTABLE HUMAN SITUATIONS

This is the ability to work productively in situations where people are angry, distressed, or tense.

EXAMPLES: (1) Work effectively in situations where there are injured or dying individuals (HIGH LEVEL).

(2) Work effectively in situations where mistakes can cause injury or death to others (MODERATE LEVEL).

(3) Work effectively for a supervisor who is often hostile or overly aggressive (LOW LEVEL).

27. EMPATHY

This is the ability to place yourself in the situation of others and to be able to understand how they are feeling.

EXAMPLES:

(1) Sign over some of your sick days to a co-worker who is having major medical problems (HIGH LEVEL).

(2) Work on your day off so your co-worker can go to a wedding of a close friend (MODERATE LEVEL).

(3) Offer the use of your pick-up truck to a young co-worker who cannot afford to rent a U-haul (LOW LEVEL).

28. SELF-ASSESSING

This is the ability to evaluate one's own performance, capabilities, and accomplishments.

EXAMPLES:

(1) Determine whether you have the skills and knowledges necessary to apply for a higher level job (HIGH LEVEL).

(2) Critique your own performance during a game of tennis (MODERATE LEVEL).

(3) List the important things you have accomplished during the work week (LOW LEVEL).

APPENDIX B

VERB/ELEMENT EXAMPLES, COLLECTION PAGE, AND ORIGINAL 11-POINT RATING SCALES FOR VERBS AND GWI ELEMENTS

EXAMPLE: ACTION VERB (CODAP)

FLY: To operate an aircraft.

Fly two ship extended formation as wingman

Fly two ship close formation as wingman

Fly two ship extended formation as lead

Fly two ship close formation as lead

EXAMPLE: GWI ELEMENT

USE OR OPERATE FLYING VEHICLES

(COLLECTION PAGE)

ABILITIES	IMPORTANCE OF ABILITY	ABILITIES	IMPORTANCE OF ABILITY
COGNITIVE ABILITIES	IF APPLICABLE	PSYCHOMOTOR ABILITIES	IF APPLICABLE
1. Verbal Comprehension		16. Static Strength	
2. Verbal Expression		17. Finger Dexterity	
3. Number Facility		18. Arm-Hand Steadiness	
4. Mathematical Reasoning		19. Multilimb Coordination	
5. Inductive Reasoning		20. Choice Reaction Time	
6. Deductive Reasoning		21. Rate Control	
7. Memorization			
8. Information Ordering		INTERPERSONAL ABILITIES	
9. Time-Sharing		22. Persuading/Influencing	
10. Flexibility of Closure		23. Cooperating	
11. Speed of Closure		24. Assuming Responsibility	
12. Perceptual Speed		25. Working Effectively in Isolation Settings	
13. Spatial Orientation		26. Working Effectively in Uncomfortable Human Situations	
14. Visualization		27. Empathy	
15. Originality		28. Self-Assessing	

ACTION VERB (CODAP)

IMPORTANCE-OF-ABILITY SCALE
(GIVEN ADEQUATE TRAINING AND EXPERIENCE)

0. **THE HIGHEST IMPORTANCE:** Less than 10 percent of the tasks associated with this verb can be correctly completed with an average level* of this ability.

1. **EXTREMELY HIGH IMPORTANCE:** About 10 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

2. **VERY HIGH IMPORTANCE:** About 20 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

3. **HIGH IMPORTANCE:** About 30 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

4. **SLIGHTLY ABOVE AVERAGE IMPORTANCE:** About 40 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

5. **AVERAGE IMPORTANCE:** About 50 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

6. **SLIGHTLY BELOW AVERAGE IMPORTANCE:** About 60 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

7. **LOW IMPORTANCE:** About 70 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

8. **VERY LOW IMPORTANCE:** About 80 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

9. **EXTREMELY LOW IMPORTANCE:** About 90 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

10. **THE LOWEST IMPORTANCE:** More than 90 percent of the tasks associated with this verb can be correctly completed with an average level of this ability.

* AVERAGE LEVEL APPLIES TO THE AVERAGE LEVEL OF THIS ABILITY FOUND IN THE TYPICAL COLLEGE GRADUATE.

GWI ELEMENT

IMPORTANCE-OF-ABILITY SCALE
(GIVEN ADEQUATE TRAINING AND EXPERIENCE)

0. **THE HIGHEST IMPORTANCE:** Less than 10 percent of the actions needed to perform the task can be correctly completed with an average level* of this ability.

1. **EXTREMELY HIGH IMPORTANCE:** About 10 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

2. **VERY HIGH IMPORTANCE:** About 20 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

3. **HIGH IMPORTANCE:** About 30 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

4. **SLIGHTLY ABOVE AVERAGE IMPORTANCE:** About 40 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

5. **AVERAGE IMPORTANCE:** About 50 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

6. **SLIGHTLY BELOW AVERAGE IMPORTANCE:** About 60 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

7. **LOW IMPORTANCE:** About 70 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

8. **VERY LOW IMPORTANCE:** About 80 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

9. **EXTREMELY LOW IMPORTANCE:** About 90 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

10. **THE LOWEST IMPORTANCE:** More than 90 percent of the actions needed to perform the task can be correctly completed with an average level of this ability.

* AVERAGE LEVEL APPLIES TO THE AVERAGE LEVEL OF THIS ABILITY FOUND IN THE TYPICAL COLLEGE GRADUATE.

APPENDIX C

NINE-POINT RATING SCALES FOR VERBS AND GWI ELEMENTS

ACTION VERB (CODAP)

IMPORTANCE-OF-ABILITY SCALE
(GIVEN ADEQUATE TRAINING AND EXPERIENCE)

9. **EXTREMELY HIGH IMPORTANCE:** Individuals need a level of this ability that is very much higher than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

8. **VERY HIGH IMPORTANCE:** Individuals need a level of this ability that is much higher than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

7. **HIGH IMPORTANCE:** Individuals need a level of this ability that is somewhat higher than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

6. **SLIGHTLY ABOVE AVERAGE IMPORTANCE:** Individuals need a level of this ability that is slightly higher than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

5. **AVERAGE IMPORTANCE:** Individuals need a level of this ability that is about the same as that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

4. **SLIGHTLY BELOW AVERAGE IMPORTANCE:** Individuals need a level of this ability that is slightly lower than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

3. **LOW IMPORTANCE:** Individuals need a level of this ability that is somewhat lower than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

2. **VERY LOW IMPORTANCE:** Individuals need a level of this ability that is much lower than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

1. **EXTREMELY LOW IMPORTANCE:** Individuals need a level of this ability that is very much lower than that possessed by the average (person) in order to successfully perform the tasks associated with this verb.

GWI ELEMENT

IMPORTANCE-OF-ABILITY SCALE
(GIVEN ADEQUATE TRAINING AND EXPERIENCE)

9. **EXTREMELY HIGH IMPORTANCE:** Individuals need a level of this ability that is very much higher than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

8. **VERY HIGH IMPORTANCE:** Individuals need a level of this ability that is much higher than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

7. **HIGH IMPORTANCE:** Individuals need a level of this ability that is somewhat higher than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

6. **SLIGHTLY ABOVE AVERAGE IMPORTANCE:** Individuals need a level of this ability that is slightly higher than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

5. **AVERAGE IMPORTANCE:** Individuals need a level of this ability that is about the same as that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

4. **SLIGHTLY BELOW AVERAGE IMPORTANCE:** Individuals need a level of this ability that is slightly lower than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

3. **LOW IMPORTANCE:** Individuals need a level of this ability that is somewhat lower than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

2. **VERY LOW IMPORTANCE:** Individuals need a level of this ability that is much lower than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.

1. **EXTREMELY LOW IMPORTANCE:** Individuals need a level of this ability that is very much lower than that possessed by the average college graduate in order to correctly complete the actions needed to perform this task.